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Applicant KELLY, Charles, P. et al	

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19 April 2000 (19.04.00)

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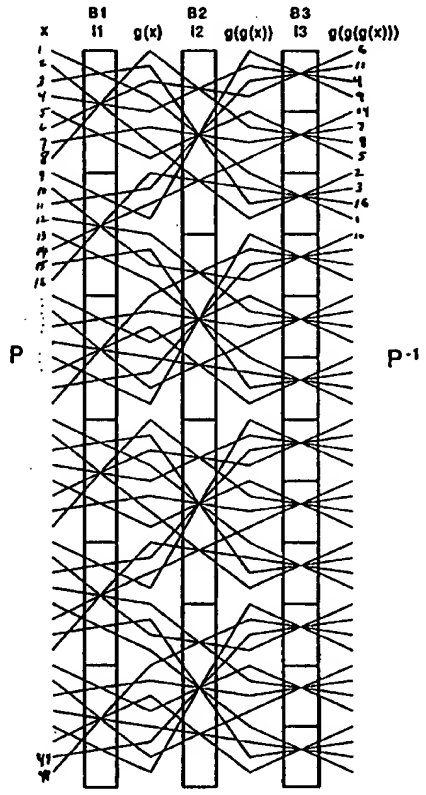
(54) Title: METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

(57) Abstract

This invention teaches a video line shuffling method wherein video line displacement is variable and controlled depending upon the distortion in a given system. A series of permutations is applied to the original picture such that lines are shuffled in a controlled manner to achieve line displacement within a desired range. Memory requirements are minimized by utilizing a method whereby a single memory has data written into locations which were read from in a previous step. Where DRAM is utilized for the memory, a write method is employed to eliminate the need for strobing the rows and columns DRAM.



$g(g(g(x,a_1,a_2),a_1,a_2),a_1,a_2)$

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METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

BACKGROUND

This invention is related to encoding and decoding of video information, and more particularly to a method and apparatus for securing the transmission of video signals so that only authorized subscribers can view transmitted video information.

Systems have been developed for scrambling television signals to secure transmission of video information. An example of a scrambling technique involves "block shuffling" wherein a television field consisting of video lines is divided into several blocks or groups of video lines. The video lines within each block are then randomly shuffled or scrambled so that the original line sequence is changed to a new scrambled line sequence within each block. The scrambled video signals are then transmitted to a receiver along with data relating to a code corresponding to the order of the randomly shuffled lines in each block. A receiver having a decoder is utilized at a subscriber location to return the lines within each block to their original sequence so that a video display of each block recreates the original field.

U.S. Patent No. 5,321,748 discloses a method and apparatus for scrambling video signals utilizing such a block shuffling technique. A block of video lines is divided into top and bottom sub block portions. The top and bottom sub block portions are switched and within each sub block portion, the video lines are randomly shuffled. This is said to improve masking of the original video information by increasing the expected value of line displacement.

U.S. Patent No. 4,405,942 discloses another method and system for secure transmission and reception of a video signal wherein parts of the video signal are delayed in relation to each other to form an encoded video signal. The encoder utilizes two field memories and a flip flop such that a first field is loaded into one of the field memories and then before the next field of video information arrives, the flip flop changes state for loading the next field of video information into the second field memory.

Several problems exist in that signal distortion effects occur during transmission. Some of these effects include field tilt or hum caused by cable amplifiers, nonlinear transmitters, or receiver imperfections. These distortion affects may change the luminance of lines in a field. Luminance is typically distorted across the field such that minimal distortion occurs at the top of the field and maximum distortion occurs at the bottom of the field. For example, line 1 may experience a low level of distortion while line 500 experiences a high level of distortion. Since the change in distortion is gradual from the top of the field to the bottom of the field, it is usually not noticeable when a television signal is transmitted and viewed at a subscriber's television. When the lines are shuffled, transmitted, and then deshuffled at a subscriber location, sharp contrasts in luminance between adjacent deshuffled lines may be visible on the video display. This occurs because the shuffled field is transmitted and the gradual distortion effect described above is applied during the transmission. During deshuffling, a line which was transmitted at position 1 with a low level of distortion may be moved next to a line which was transmitted at position

500 having a high level of distortion creating an undesirable effect which is visible in the television picture received at the subscriber location. This problem is exaggerated by increasing the average expected line displacement during the shuffling process. Therefore, the maximum average line displacement will be limited by the transmission network causing the distortion. For example, a network having high distortion can accommodate a smaller average line displacement than a network having lower distortion. Since increasing average line displacement improves masking, it is therefore desirable to transmit scrambled signals having the maximum average line displacement which network distortion permits.

Another problem exists in that systems for encoding or decoding the video signals typically utilize a plurality of memories for processing. This increases the number of components necessary to implement such a system and also introduces unwanted delay in signal processing.

SUMMARY

It is therefore an object of the present invention to provide a method and apparatus for scrambling and descrambling video signals utilizing a shuffling technique which is adaptable to a given network for maximizing masking of the video signal while minimizing undesirable effects of network distortion.

It is a further object of the invention to implement such a system in order to minimize the number of memory components and delay in signal processing.

These and other objects have been achieved by providing a method for video line shuffling wherein a picture field containing a plurality of lines is first applied to a shuffling function having a first block size parameter and a first increment parameter. Next, the shuffled lines are applied to a second shuffling function having a second block size parameter and a second increment parameter. Memory requirements are reduced in the deshuffling method by utilizing a single memory and writing to locations in that memory in a step immediately following a read from the respective locations. Where the memory device utilized is a DRAM, a method is presented for refreshing rows and columns of the DRAM without the need for strobing.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block representation of the shuffling and deshuffling process.

Figure 2 is a diagram of a recursive function for shuffling or deshuffling lines of a video field.

Figure 3 is a graph showing input line number versus output line number for a first shuffling method.

Figure 4 is a graph showing input line number versus output line number for a second shuffling method.

Figure 5 is a diagram of a video shuffling method having reduced memory requirements.

Figure 6 is a table showing memory write locations for a series of video line samples.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The video line shuffling method will first be described generally with reference to **Figure 1.** A shuffler first applies a permutation **P** to an original picture **10**. The permutation **P** rearranges the line sequence of the original picture **10** to form a shuffled picture **20**. The shuffled picture **20** is considered to be masked or secure because if viewed on a monitor or television, the original picture **10** is unintelligible.

The shuffled picture **20** is transmitted over a network to a set top terminal having a deshuffler for reconstructing the original picture **10**. The deshuffler serves to apply an inverse permutation $\mathbf{P}^{-1}$ to the shuffled picture **20** to create a reconstructed picture **10'**. The deshuffler having the inverse permutation $\mathbf{P}^{-1}$ rearranges the shuffled lines into their original positions to reconstruct the original picture.

The shuffling method will now be described in greater detail with reference to **Figure 2**. The permutation **P** is defined by a series of shuffling functions g(x). Each shuffling function g(x) is defined by a pair of shuffle parameters (B, I) where the B values correspond to a block size and the I values correspond to an increment within the block. Therefore, if the line number, x is known, each shuffling function can be described by:

g(x,B,I)

To complete the permutation, a series of shuffling functions may be applied to the original picture **10**. **Figure 2**, for example, shows the application of three such shuffling functions resulting in the permutation defined by:

g(g(g(x,B1,I1),B2,I2),B3,I3)

where x is the original line number of a given line in a field, **Bn** is a parameter defining the block size for a respective shuffling function **n**, and **In** is a parameter defining an increment within the blocks for the respective shuffling function **n**. Following a line, for example line 1, through the permutation, it can be seen that line 1 enters the first shuffling function and exits at position 4. It then exits the second shuffling function at position 9 and exits the third shuffling function at position 12. The inverse permutation $\mathbf{P}^{-1}$ is represented by a reverse path traveling from the right to left side of **Figure 2**. It should be understood that B and I values can be selected to achieve a number of different permutations **P** and inverse permutations $\mathbf{P}^{-1}$. By selecting B and I values the permutation **P** can be designed to limit line displacement. For example, in **Figure 2**, B1, B2 and B3are selected so that the resultant blocks have coincident boundaries **H1, H2, H3** at the center of each shuffling function. The result is that no line will cross the center of the permutation **P** thus limiting maximum line displacement to within on half of the picture **10**.

Referring now to **Figures 3** and **4**, results data will be described for two different permutations applied by the shuffler of **Figure 1**. It should be understood that these permutations are shown to illustrate how masking is limited by system

distortion. Also, these permutations are different from the permutation presented in **Figure 2**. **Figure 3** shows a graphical representation of input line versus output line numbers for a first selected permutation **P**. The resultant pattern indicates that each line of the original picture **10** is moved only a small amount in the shuffle picture **20**. This permutation is desirable for systems that have high levels of distortion introduced during transmission. The reconstructed picture **10'** will exhibit only minor distortion upon reconstruction. This permutation, however, provides a low level of masking since the lines are shuffled in a pattern along a relatively small displacement.

Figure 4 shows a graphical representation of input line versus output line number for a second permutation **P**. This permutation, exhibits a high level of line displacement and is suitable for systems containing less distortion. It can be appreciated that this permutation provides a higher degree of masking since lines are displaced more than the those of **Figure 3**.

Video line shuffling/deshuffling methods require the use of memory, typically random access memory (RAM), for temporarily storing and reading lines during permutation. Since reducing the number of components in such a system often reduces the cost, it is desirable to minimize the amount of memory necessary for performing the shuffling and deshuffling method. Additionally, memory typically represents a large percentage of the cost associated with a finished terminal containing the deshuffler. As described in the background section, known techniques utilize a pair of memories, one memory typically is written to in a cycle

while the other memory is typically read from in order to perform the deshuffling. **Figure 5** shows a method of deshuffling utilizing an exemplary single four location memory. It should be understood that while a four location memory is utilized in this example in order to simplify the explanation, smaller or larger memories can be utilized with this method. Also, for ease of explanation, a simplified permutation **M** and inverse permutation $\mathbf{M}^{-1}$ will be described. Those reasonably skilled in the art will appreciate that a more complex permutation such as that shown in **Figure 2** could be applied to this method. The memory which will be described is located within a decoder which is typically part of a set top terminal at a subscriber location. The shuffler is typically positioned at the head end of a video transmission system.

Beginning at the upper left corner of **Figure 5**, in the first step, an original line sequence of 1, 2, 3, 4 has been stored in the memory. A deshuffler reads the memory in order such that 1 is read from the first position. Next, the shuffler sends a permutation 2, 3, 1, 4 which is stored in consecutive memory locations as shown in steps 2-5. Also during this second step, the deshuffler continues to read from the memory in order such that the second, third and fourth locations are read. During the fifth step, the deshuffler does not read from the memory. This is because between steps 5 and 6, the Verticle Blanking Interval (VBI) occurs. This is shown by way of example to illustrate how an interval is provided between steps for the VBI. Those skilled in the art will appreciate that while the VBI is shown between steps 5 and 6 and again between steps 10 and 1, the method can be adapted to provide this interval between different steps according to timing requirements of any

given system. In step 6, the deshuffler reads from memory locations utilizing the inverse permutation 3, 1, 2, 4. In step 7 the shuffler begins consecutively storing according to the inverse permutation 3, 1, 2, 4. It should be noticed that in each step where the shuffler stores a value into a memory location, the deshuffler in the previous step has read from that same location. Therefore, each memory location is utilized as soon as it is made available by having been read from It should be noted that the shuffler sends the inverse permutation M^{-1} based upon the location number of the most recently read data in steps 6-10. For example in step 6, a 1 is read from location 3, therefore in step 7, the shuffler sends a 3 corresponding to the location number previously read. In step 7 the deshuffler reads 2 from location 1, therefore the shuffler sends a 1 corresponding to the location number previously read. Based upon this logic, the inverse permutation 3, 1, 2, 4 is generated.

Another method of reducing cost of the finished terminal is to select lower cost memory components. For example, DRAM may be suitable from economic and design requirements perspectives. The use of DRAM as a memory device for the deshuffler and a novel write method will now be described in greater detail with reference to **Figure 6**. First it should be understood that each line of video is digitally sampled for storage in the memory. In this example, 909 samples are taken per line. It should also be understood that the number of samples may be selected according to system design requirements. DRAM is typically arranged to have locations in rows and columns. In order to refresh a row of DRAM, it is necessary to either write to or strobe any column in that row. Likewise, in order to refresh any

column, it is necessary to write to or strobe any row along that column. It is necessary to refresh all rows and columns at a minimum time interval prescribed by the DRAM. In this case, the refresh rate for the selected DRAM is 8 ms. Since DRAM is required to have its columns and rows refreshed at the refresh rate, they are typically strobed to maintain the data stored in locations in the associated rows and columns. A problem is presented in that strobing requires added bandwidth to send the strobe signals. The following method eliminates the need for the strobe signals and therefore reduces bandwidth requirements. Write locations are selected in such a way that rows and columns are written to within a minimum time interval prescribed by the refresh rate to avoid losing data stored therein and to avoid the need to strobing the rows or columns.

Referring now to **Figure 6**, the storage of 909 samples representing video line 0 will be described.. The first 127 samples are written into row 0. Along row 0 of the DRAM, the samples are written into columns 0 through 127. The samples 128-255 are next written into row 64, columns 128-225. This pattern continues until sample 512. The particular DRAM selected for this application utilizes a nine bit column address having a maximum value of 511. Continuing along video line 0, samples 512-639 are written into row 256, columns 0-127. It is therefore evident that the column numbers wrap back to 0 after reaching the maximum value of 511. Continuing along video line 0, samples 640-767 are written into row 320, columns 128-255. Samples are written at an approximate rate of 14 million samples per second. This allows 128 lines of 909 samples to be written into DRAM every 8 ms.

With each line being written according to **Figure 6**, this method serves to refresh each column and each row within the given time interval necessary for the DRAM.

An advantage of the present invention is that the shuffling method provides a controlled amount of maximum line displacement which is adjustable depending upon the distortion present in a given system. This provides for a maximum masking level within the confines of system distortion.

An additional advantage is that one memory may be utilized to deshuffle a shuffled picture.

An additional advantage is that where DRAM is utilized for the memory, the need for strobing or refreshing the memory is eliminated.

It should be understood that while this invention is presented here in the form of the embodiments shown, the scope of the invention is intended to be limited only by the following claims.

What is claimed is:

1. A video line shuffling method comprising the steps of:

applying a first shuffling function to a plurality of lines, the first shuffling function having a first block size parameter and a first increment parameter;

applying a second shuffling function to the plurality of lines, the second shuffling function having a second block size parameter and a second increment parameter.

2. The video line shuffling method of claim 1 wherein line displacement in each shuffling function is limited to be within a block defined by the respective block size parameters.

3. The video line shuffling method of claim 2 wherein line displacement within each block is limited by the increment parameter.

4. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to the plurality of lines, the third shuffling function having a third block size parameter and a third increment parameter.

5. The video line shuffling method of claim 4 further comprising the step of applying a series of shuffling functions to the plurality of lines, the series containing

at least one shuffling function having a respective block size parameter and a respective increment parameter.

6. The video line shuffling method of any one of claims 1 to 5 wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

7. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

sequentially writing the first series of data into the memory such that data is written into a memory location immediately after that memory location has been read,

sending a second series of data according to an inverse of the first permutation from the shuffler to the deshuffler; and

writing to memory locations defined by the data in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

8. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data;

dividing the lines into subsets each having a second length being smaller that the first length;

writing each subset into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

9. The method of claim 8 wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *

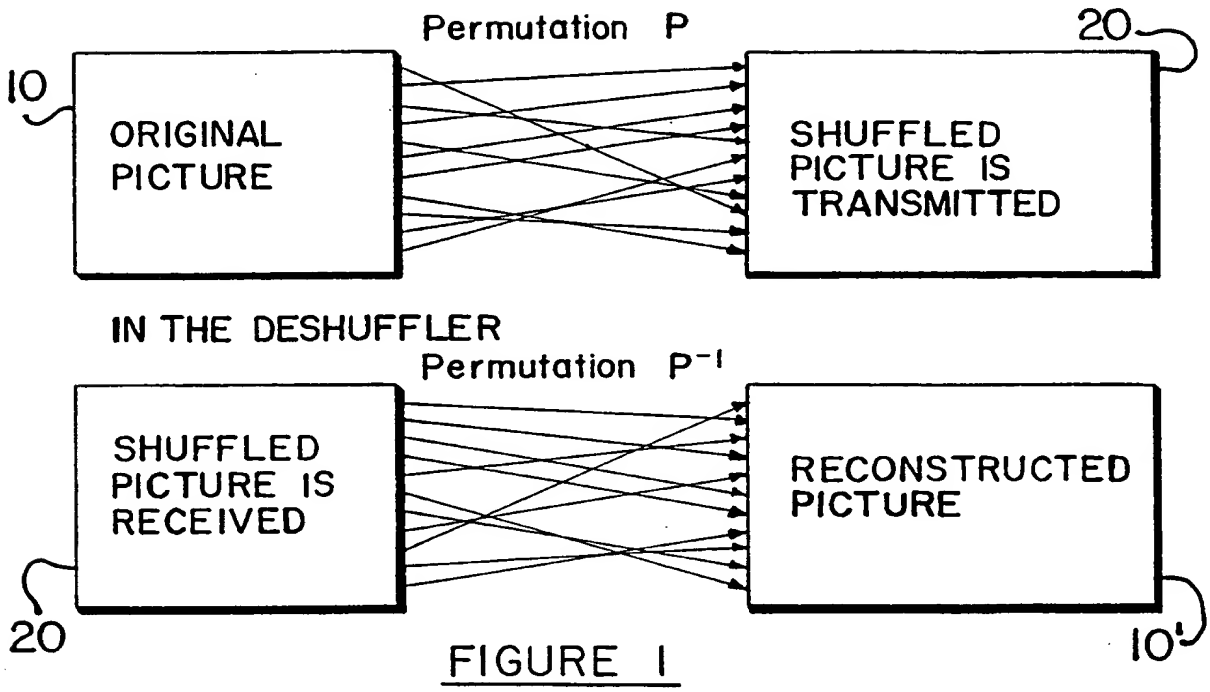
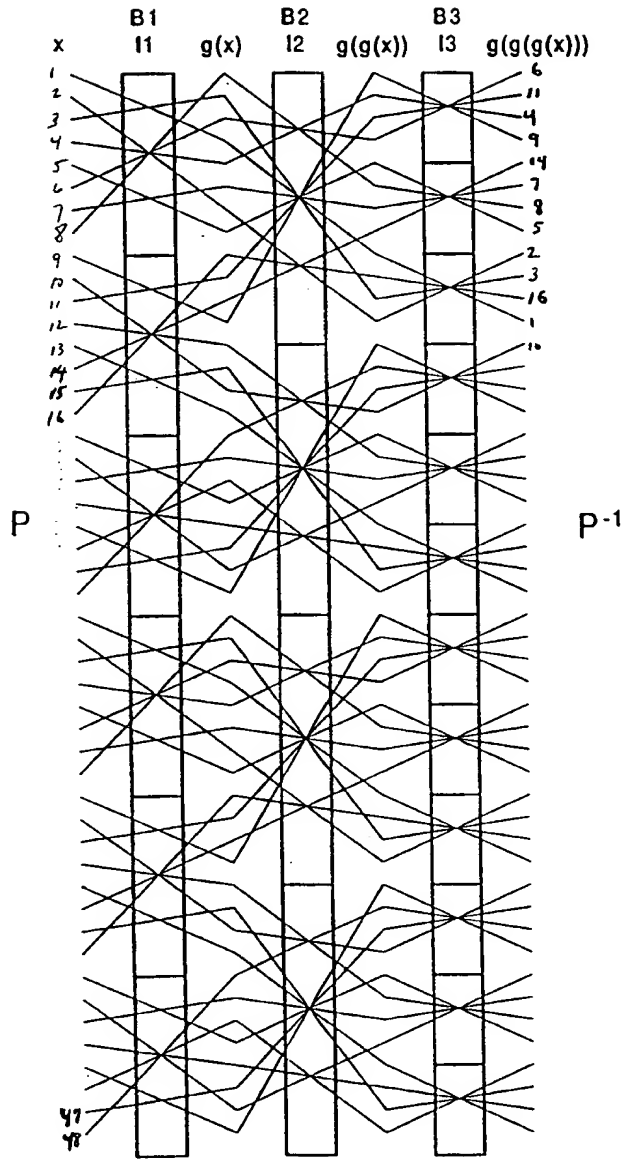

IN THE SHUFFLER:
Permutation P
10
20
ORIGINAL PICTURE
SHUFFLED PICTURE IS TRANSMITTED
IN THE DESHUFFLER
Permutation P^{-1}
SHUFFLED PICTURE IS RECEIVED
RECONSTRUCTED PICTURE
20
10'

FIGURE 1



$g(g(g(x, O_1, I_1), O_2, I_2), O_3, I_3)$

Figure 2

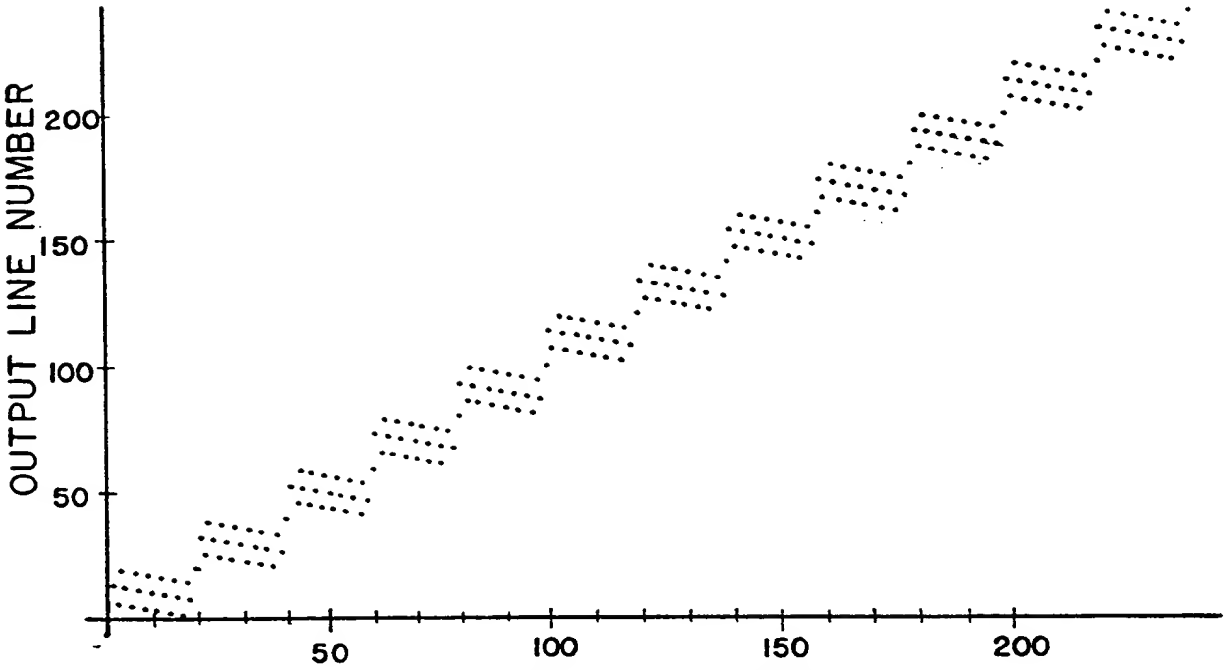


FIGURE 3

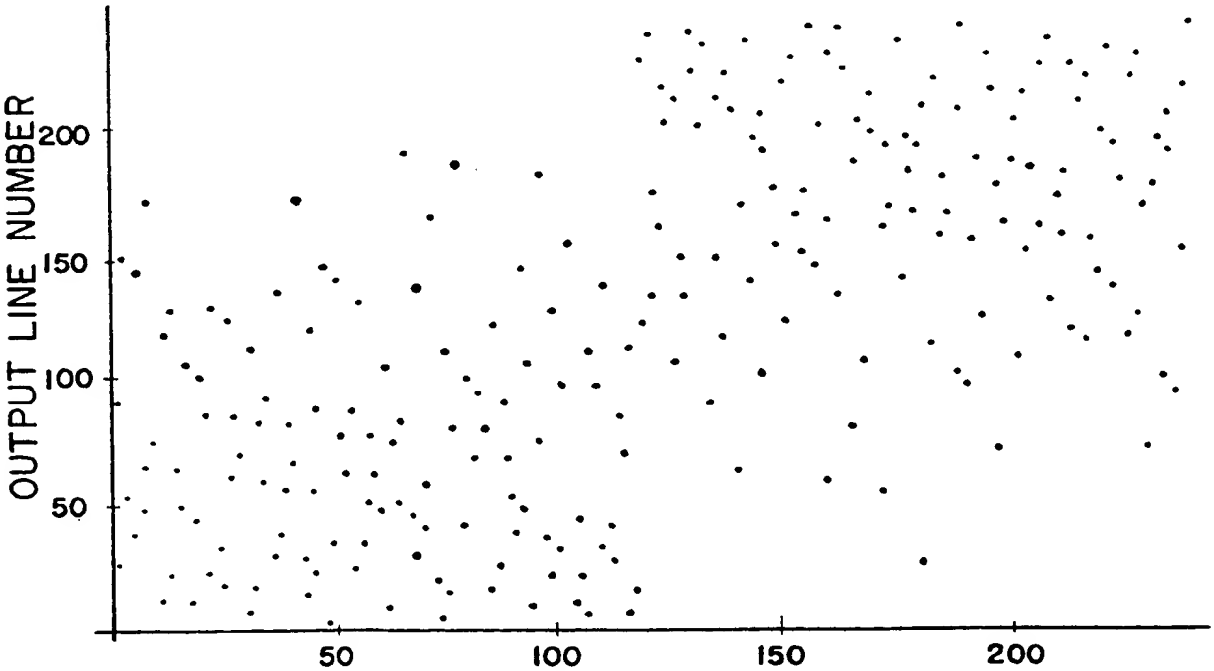


FIGURE 4

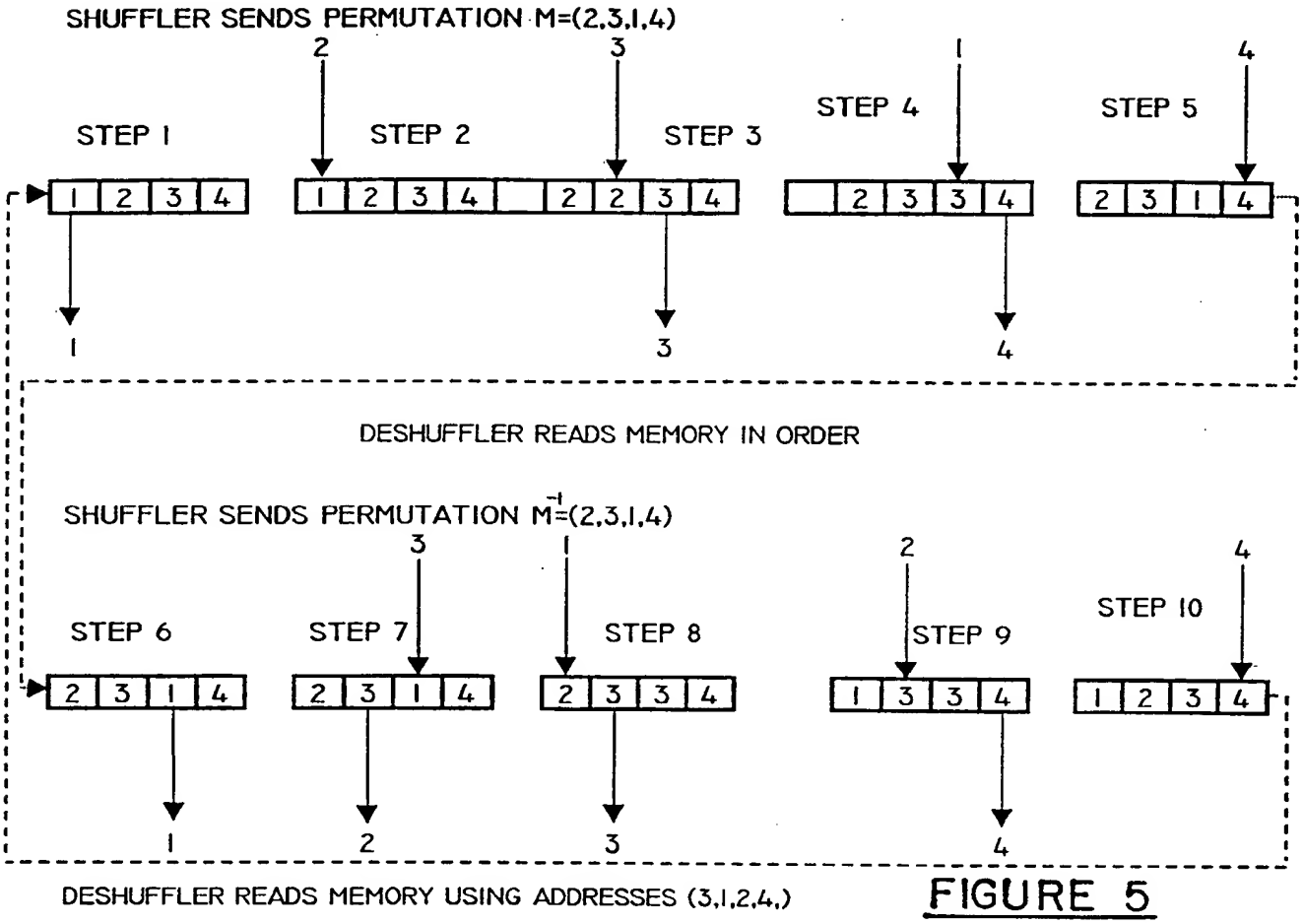


FIGURE 5

VIDEO LINE	ROW DURING SAMPLES							
	0-127	128-255	256-383	384-511	512-639	640-767	768-895	896-908
0	0	64	128	192	256	320	384	448
1	1	65	129	193	257	321	385	449
2	2	66	130	194	258	322	386	450
3	3	67	131	195	259	323	387	451
4	4	68	132	196	260	324	388	452
...	...	...	...	...	...	...	...	...
63	63	127	191	255	319	383	447	511
64	64	128	192	256	320	384	448	0
65	65	129	193	257	321	385	449	1
66	66	130	194	258	322	386	450	2
67	67	131	195	259	323	387	451	3
...	...	...	...	...	...	...	...	...
N	N	(N+64) %512	(N+128) %512	(N+192) %512	(N+256) %512	(N+320) %512	(N+384) %512	(N+448) %512

FIGURE 6

INTERNATIONAL SEARCH REPORT

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IPC 7 H04N7/169

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Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 321 748 A (ZEIDLER DAVID E ET AL) 14 June 1994 (1994-06-14) column 4, line 50 -column 11, line 2 figures 1-6	1-6,8,9
X	WO 93 07716 A (THOMSON CONSUMER ELECTRONICS) 15 April 1993 (1993-04-15) page 6, line 16 -page 7, line 20 page 11, line 11 -page 16, line 19 page 17, line 12 -page 18, line 20 page 20, line 16 -page 27, line 6 figures 1-15	1-7

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 January 2000	17/01/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Van der Zaal, R

1

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/21666

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5321748 A	14-06-1994	NONE	
WO 9307716 A	15-04-1993	AU 2646892 A	03-05-1993
		AU 2657092 A	03-05-1993
		AU 2678392 A	03-05-1993
		CN 1074072 A	07-07-1993
		CN 1071039 A	14-04-1993
		CN 1071797 A	05-05-1993
		DE 69228250 D	04-03-1999
		DE 69228440 D	25-03-1999
		EP 0606300 A	20-07-1994
		EP 0606328 A	20-07-1994
		EP 0606346 A	20-07-1994
		WO 9307717 A	15-04-1993
		WO 9307718 A	15-04-1993
		JP 6511122 T	08-12-1994
		JP 6511123 T	08-12-1994
		JP 6511124 T	08-12-1994
		MX 9205587 A	01-03-1993
		MX 9205588 A	29-07-1994
		TR 27727 A	22-06-1995
		TR 27057 A	11-10-1994
		TR 26199 A	15-02-1995
		TR 26360 A	15-03-1995
		US 5555305 A	10-09-1996
		ZA 9207509 A	28-06-1994
		ZA 9207510 A	28-06-1994
		ZA 9207511 A	28-06-1994

15

PATENT COOPERATION TREATY

REC'D 18 JAN 2001

WIPO PCT

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference ./.	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US99/21666	International filing date *(day/month/year)* 20/09/1999	Priority date *(day/month/year)* 21/09/1998
International Patent Classification (IPC) or national classification and IPC H04N7/169		
Applicant GENERAL INSTRUMENT CORPORATION et al..		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 3 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
19/04/2000	16.01.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Zanella, C Telephone No. +49 89 2399 8960

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/US99/21666

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1-11	as originally filed				

Claims, No.:

1-8	as received on	28/12/2000	with letter of	22/12/2000	

Drawings, sheets:

1/4-4/4	as originally filed				

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   - ☐ the description, pages:
   - ☒ the claims, Nos.: 1-9

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

   ☐ restricted the claims.

   ☒ paid additional fees.

   ☐ paid additional fees under protest.

   ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

   ☐ complied with.

   ☒ not complied with for the following reasons:
   see separate sheet

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-8
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-8
	No:	Claims	

Industrial applicability (IA) Yes: Claims 1-8
No: Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

ITEM IV

1. It is found that no common concept links the groups of claims (a)1-5 (b) 6 and (c) 7-8, since these three groups of claims respectively relate to (1) a video line shuffling method providing a controlled amount of maximum line displacement which is adjustable depending upon the distortion present in a given system (2) a second video line shuffling method having no points in common with the first one and aimed at using only one memory to deshuffle a shuffled picture and (3) a method of writing data into a memory which avoids the need for strobing or refreshing the memory.

2. The present application therefore does not comply with the requirements of unity of invention (Rule 13.1 PCT) since three different inventions are claimed.

ITEM V

1. Reference is made to the following documents:

D1: US-A-5 321 748 (ZEIDLER DAVID E ET AL) 14 June 1994 (1994-06-14)
D2: WO 93 07716 A (THOMSON CONSUMER ELECTRONICS) 15 April 1993

2. In the prior art disclosed by documents D1 and D2 the plurality of lines forming an image can be grouped into a plurality of blocks and shuffling of lines within a block can be carried out using pseudo-random number generators and seeds. In these disclosed methods shuffling of lines is limited to the dimension of a block as in the method described in the present application. However, the use of a pseudo-random generator rather than the claimed shuffling functions has as a consequence that different blocks of a same field are shuffled in different manners, contrary to the claimed method where all these blocks are shuffled in a same deterministic manner, dependent on the size of the block and on the shuffling increment (see figure 2).

The use of a sequence of two -or more- shuffling functions, as claimed,

each of them depending on parameters representing the size of the shuffling block and the shuffling increment used makes it possible to determine for a particular distortion characteristic of a network a most suitable shuffling pattern.

3. The subject-matter of claim 6 suggests to send data according to the inverse of a preceding transmitted permutation in order be able to write data into a memory location immediately after that said memory location has been read. The available documents do not give any hint leading to this concept and therefore the subject-matter of claim 7 appears to involve an inventive step.

4. The subject-matter of claims 7 and 8 concerns a method of writing lines in a memory where a line is divided into a number of parts and written in different rows of a memory in order to eliminate the need for refreshing the memory. The available documents do not give any hint leading to this concept and therefore the subject-matter of claim 8 and 9 appears to involve an inventive step.

5. The presently claimed subject-matter relates to the field of electronics and in particular to the design of electronic devices which are then manufactured by the industry. The present claims possess thus industrial applicability.

ITEM VII

Independent claim 1 is not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (see either document D1 or D2) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

ITEM VIII

The presence of claim 2 renders the subject-matter of claim 1 unclear.

According to claim 2 the line displacement within the blocks is **limited** by a respective increment parameter; in this connection It appears that the values of displacements of lines within a block do not directly correspond to an increment parameter since the latter can be applied in a "circular" fashion and therefore only represents a maximum possible displacement.

However, claim 2 is dependent on claim 1 and for this reason should only cover a particular embodiment. The wording of claim 2 therefore suggests that in claim 1 the line displacements could **also not** be limited by respective increment parameters, so that obscurities are introduced regarding the purpose of the "increment parameters".

What is claimed is:

1. A video line shuffling method comprising the steps of:

applying a first shuffling function to a plurality of lines, the first shuffling function having a first block size parameter and a first increment parameter;

applying a second shuffling function to the plurality of lines, the second shuffling function having a second block size parameter and a second increment parameter.

2. The video line shuffling method of claim 1 wherein line displacement in each shuffling function is limited to be within a block defined by the respective block size parameters.

3. The video line shuffling method of claim 2 wherein line displacement within each block is limited by the increment parameter.

4. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to the plurality of lines, the third shuffling function having a third block size parameter and a third increment parameter.

5. The video line shuffling method of claim 4 further comprising the step of applying a series of shuffling functions to the plurality of lines, the series containing

at least one shuffling function having a respective block size parameter and a respective increment parameter.

6. The video line shuffling method of any one of claims 1 to 5 wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

7. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

sequentially writing the first series of data into the memory such that data is written into a memory location immediately after that memory location has been read,

sending a second series of data according to an inverse of the first permutation from the shuffler to the deshuffler; and

writing to memory locations defined by the data in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

8. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data;

dividing the lines into subsets each having a second length being smaller that the first length;

writing each subset into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

9. The method of claim 8 wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *

P. ENT COOPERATION TREA.

From the:
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
VOLPE,KOENIG III
Volpe & Koenig, P.C.
Suite 400
One Penn Center
1617 John F. Kennedy Boulevard
Philadelphia, PA 19103
ETATS-UNIS D'AMERIQUE

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AM/PM
OCT 0 2 2000
VOLPE & KOENIG, P.C.

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing *(day/month/year)*	22.09.2000
Applicant's or agent's file reference: ./. MOT-02191 WO	**REPLY DUE** **within 3 month(s)** from the above date of mailing

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US99/21666	20/09/1999	21/09/1998

International Patent Classification (IPC) or both national classification and IPC
H04N7/169

Applicant
GENERAL INSTRUMENT CORPORATION et al..

1. This written opinion is the **first** drawn up by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

I	☒	Basis of the opinion
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain document cited
VII	☒	Certain defects in the international application
VIII	☒	Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also: For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4 bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 21/01/2001.

Name and mailing address of the international preliminary examining authority:
European Patent Office
D-80298 Munich
Tel. +49 89 2399 - 0 Tx: 523656 epmu d
Fax: +49 89 2399 - 4465

Authorized officer / Examiner
Zanella, C

Formalities officer (incl. extension of time limits)
SCHALINATUS, D
Telephone No. +49 89 2399 8242

I. Basis of the opinion

1. This opinion has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".*):

Description, pages:

1-11 as originally filed

Claims, No.:

1-9 as originally filed

Drawings, sheets:

1/4-4/4 as originally filed

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. This opinion has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

IV. Lack of unity of invention

1. In response to the invitation (Form PCT/IPEA/405) to restrict or pay additional fees, the applicant has:

☐ restricted the claims.

☒ paid additional fees.

☐ paid additional fees under protest.

☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with for the following reasons

and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees:

3. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this opinion:

   ☒ all parts.

   ☐ the parts relating to claims Nos. .

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	
Inventive step (IS)	Claims	1-9
Industrial applicability (IA)	Claims	

2. Citations and explanations

   see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

ITEM V

1. Reference is made to the following documents:

D1: US-A-5 321 748 (ZEIDLER DAVID E ET AL) 14 June 1994 (1994-06-14)
D2: WO 93 07716 A (THOMSON CONSUMER ELECTRONICS) 15 April 1993

2. The subject-matter of claim 1 and therefore also that of its dependent claims 2-6 is not clear (see ITEM VIII).

However, it appears that a clarified version of these claims could involve an inventive step having regard to the disclosures of documents D1 and D2, since in these documents shuffling of lines in a block is carried out using pseudo-random number generators and seeds. In these disclosed methods shuffling of lines is limited to the dimension of a block as in the method described in the present application. However, the use of a pseudo-random generator rather than the claimed shuffling function has as a consequence that different blocks of a same field are shuffled in a different manner, contrary to the claimed method where all the blocks are shuffled in a same deterministic manner, dependent on the size of the block and on the shuffling increment (see figure 2).

3. The subject-matter of claim 7 suggests to send data according to the inverse of a preceding transmitted permutation in order be able to write data into a memory location immediately after that said memory location has been read. The available documents do not give any hint leading to this concept and therefore the subject-matter of claim 7 appears to involve an inventive step.

4. The subject-matter of claims 8 and 9 concerns a method of writing lines in a memory where a line is divided into a number of parts and written in different rows of a memory in order to eliminate the need for refreshing the memory. The available documents do not give any hint leading to this concept and therefore the subject-matter of claim 8 and 9 appears to involve an inventive step.

ITEM VII

The independent claims are not in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art (see either document D1 or D2) being placed in the preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in the characterising part (Rule 6.3(b)(ii) PCT).

ITEM VIII

The subject-matter of claim 1 is not clear for the following reasons:

(a) it is not clear that the video shuffling method should be applied to a picture field divided into a plurality of blocks,

(b) it is not clear that the line displacement is limited to be within the blocks (this feature is also disclosed by documents D1 and D2)

(c) it is not clear that the first block size parameter **is the same as** the block size of the block to which shuffling is applied

(d) it is not clear that the first increment parameter **is the same as** the number line increment used to shuffle the lines (as shown by figure 2)

(e) points (c) and (d) also apply to the second block size parameter and to the second increment parameter

(f) it is not clear that the second shuffling function is applied to a picture field shuffled by the first shuffling function

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Generaldirektion 2 | Directorate General 2 | Direction Générale 2

Correspondence with the EPO on PCT Chapter II demands

In order to ensure that your PCT Chapter II demand is dealt with as promptly as possible you are requested to use the enclosed self-adhesive labels with any correspondence relating to the demand sent to the Munich Office.

One of these labels should be affixed to a prominent place in the upper part of the letter or form etc. which you are filing.

IN THE INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY
EUROPEAN PATENT OFFICE

In the **PCT APPLICATION** of:

General Instrument Corporation

Application No.: PCT/US99/21666

Filed: 20 September 1999

For: METHOD AND APPARATUS FOR SHUFFLING AND DESHUFFLING VIDEO SIGNALS

Authorized Officer: C. Zanella

Our File: MOT-D2191WO

Date: 22 December 2000

8 PAGES VIA FACSIMILE TO 011-49-89-2399-4465 ORIGINAL TO FOLLOW VIA DHL COURIER

REPLY TO FIRST WRITTEN OPINION WITH ARTICLE 34 AMENDMENT

IPEA-EPO
D-80298 Munich
GERMANY

Sir:

This Reply is responsive to the Written Opinion dated 22 September 2000. Pursuant to Article 34, please amend the application by substituting new pages 12-14 in the claims for existing pages 12-14.

The claims have been revised to address the informalities raised by the Examiner. A marked up copy of all the substitute sheets numbered 12-14 indicating inserted material with underlining and deleted material with brackets is also faxed herewith, which illustrates the changes made in the substitute sheets. Applicant believes that all informalities raised by the Examiner in the Written Opinion have been addressed.

It is respectfully submitted that the claims satisfy the novelty, inventive step and industrial applicability requirements. In the event that a negative statement with

respect to the new claims is made applicant respectfully request an additional opportunity to respond pursuant to Rule 66.4(b).

Respectfully submitted,

General Instrument Corporation

By_____
Gerald B. Halt, Jr.
Telephone: 01-215-568-6400
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GBH/DWS/kag
Enclosures

What is claimed is:

1. A method for shuffling a plurality of video lines; the plurality of video lines being grouped into a plurality of blocks, whereby the video lines are shuffled within each said block, comprising the steps of:

applying a first shuffling function to a plurality of lines within a first block to generate a first plurality of permutated lines, the first shuffling function using a first block size parameter B_1 and a first increment parameterI_1; and

applying a second shuffling function to said first plurality of permutated lines within a second block to generate a second plurality of permutated lines, the second shuffling function using a second block size parameter B_2 and a second increment parameter I_2.

2. The video line shuffling method of claim 1 wherein line displacement within said first and second blocks is limited by the respective increment parameter I_1, I_2.

3. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to said second plurality of permutated lines, the third shuffling function having a third block size parameter B_3 and a third increment parameter I_3.

4. The video line shuffling method of claim 3 further comprising the step of applying a series of shuffling functions to a series of pluralities of permutated lines, the series containing at least one shuffling function having a respective block size parameter B and a respective increment parameter I.

5. The video line shuffling method of any one of claims 1 to 4 wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

6. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

characterized in that:

the first series of data is sequentially written into the memory such that data is written into a memory location immediately after that memory location has been read,

a second series of data is sent according to an inverse of the first permutation from the shuffler to the deshuffler; and

memory locations defined by the data are written to in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

7. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data; characterized in that:

said lines are divided into subsets each having a second length being smaller than the first length; and

each subset is written into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

8. The method of claim 7 wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *

What is claimed is:

1. A [video line shuffling] method for shuffling a plurality of video lines; the plurality of video lines being grouped into a plurality of blocks, whereby the video lines are shuffled within each said block, comprising the steps of:

applying a first shuffling function to a plurality of lines within a first block to generate a first plurality of permutated lines, the first shuffling function [having a first block size parameter] using a first block size parameter B_1 and a first increment parameterI_1; and

applying a second shuffling function to said first [the] plurality of permutated lines within a second block to generate a second plurality of permutated lines, the second shuffling function using a second block size parameter B_2 [having a second block size parameter] and a second increment parameter I_2.

[2. The video line shuffling method of claim 1 wherein line displacement in each shuffling function is limited to be within a block defined by the respective block size parameters.]

2 [3]. The video line shuffling method of claim 1 [2] wherein line displacement within [each] said first and second blocks is limited by the respective increment parameter I_1, I_2.

3 [4]. The video line shuffling method of claim 1 further comprising the step of applying a third shuffling function to said second [the] plurality of permutated lines, the third shuffling function having a third block size parameter B_3 and a third increment parameter I_3.

4 [5]. The video line shuffling method of claim 3 [4] further comprising the step of applying a series of shuffling functions to a series of [the plurality] pluralities of permutated lines, the series containing at least one shuffling function having a respective block size parameter B and a respective increment parameter I.

5 [6]. The video line shuffling method of any one of claims 1 to 4 [5] wherein the block size parameter of one of the shuffling functions defines a block having at least one boundary coincident with a boundary of a block of another shuffling function.

6 [7]. A video line shuffling method utilizing a shuffler at a first location and a deshuffler having a memory at a second location, the method comprising the steps of:

sending a first series of data shuffled according to a first permutation from the shuffler to the deshuffler;

characterized in that:

[sequentially writing] the first series of data is sequentially written into the memory such that data is written into a memory location immediately after that memory location has been read,

[sending] a second series of data is sent according to an inverse of the first permutation from the shuffler to the deshuffler; and

[writing to] memory locations defined by the data are written to in the inverse permutation such that data is written into a memory location immediately after that memory location has been read.

7 [8]. A method of writing data into a memory having C columns and R rows defining a plurality of memory locations, the method comprising the steps of:

dividing the data into lines wherein each line contains a first length of data; characterized in that:

[dividing the] said lines are divided into subsets each having a second length being smaller [that] than the first length; and

[writing] each subset is written into a selected row and column range of the memory such that each time a subset is written, the selected row is incremented by a value I.

8 [9]. The method of claim 7 [8] wherein I is selected so that each row has data written therein within a minimum selected time interval.

* * *